

Selection of Leafy Green Vegetable Varieties for a Pick-and-eat Diet Supplement on ISS

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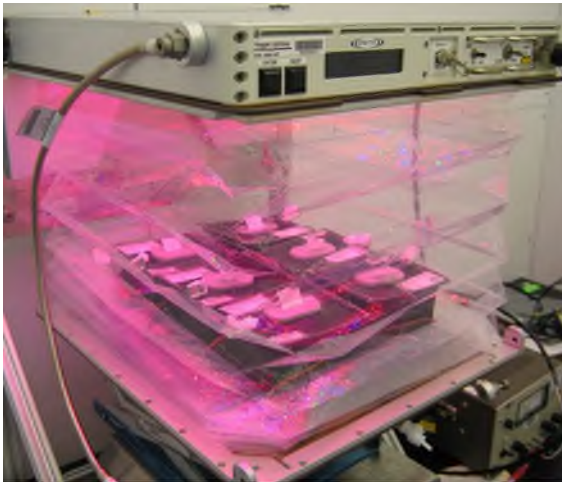
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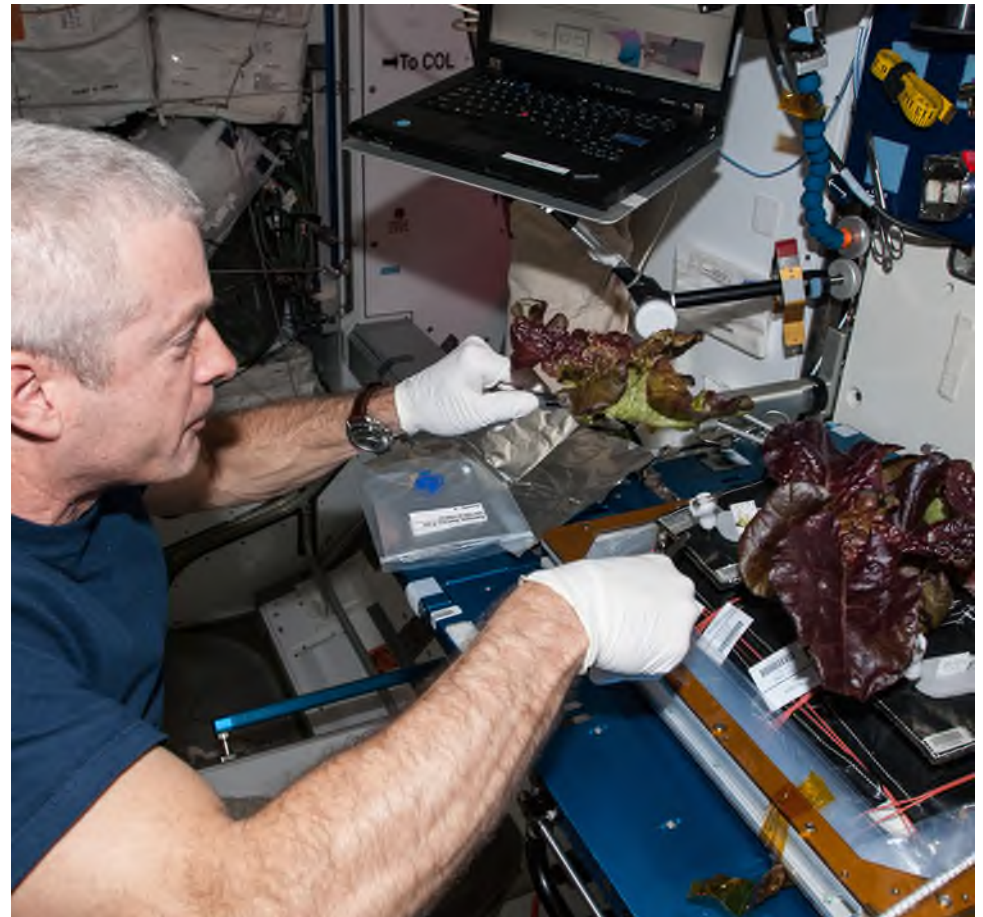
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Goal: To down select crop candidates for crew to grow, pick, and eat on ISS to supplement a packaged diet.

ISS crop production would likely use the Veggie hardware or a similar growth system.



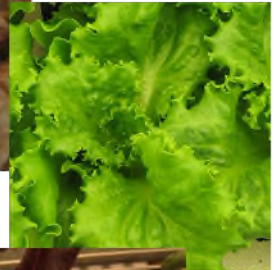
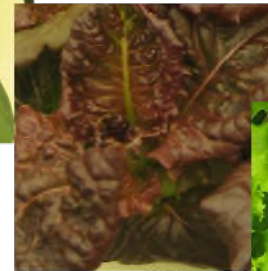
Veggie is currently on ISS in the Columbus module.



ISS Cmdr. Swanson harvesting lettuce from the Veggie test– June, 2014

Leafy Greens - Candidates

- 'Tyee' spinach
- 'Flamingo' spinach
- 'Outredgeous' Red Romaine lettuce
- 'Waldmann's Dark Green' Leaf lettuce
- 'Bull's Blood' beet
- 'Rhubarb' Swiss chard
- 'Tokyo Bekana' Chinese cabbage
- Mizuna



Selection Criteria Overview

- Horticultural factors
 - Germination, ease of growth, amount of growth (food), size
- Dietary factors
 - Percent dry matter
 - Elemental Factors - Composition of key elements (K, Fe, Ca, Mg)
 - Nutrient Factors - Beneficial phytonutrients (Vitamin K, Lutein, Zeaxanthin, Antioxidants)
- Organoleptic factors
 - 9-pt Hedonic Scale: Overall taste, Appearance, Color, Bitterness, Flavor, Texture
 - 5-point Just About Right Scale: Crispness, Tenderness

Weighting and Ranking

- Weighting factors were developed for each parameter based on subjective importance.
- Data were normalized, weighted, and ranked.
- Divided into:
 - Horticultural Factors
 - Elemental Factors
 - Nutrient Factors
 - Organoleptic Factors
- 8 varieties were down selected to 4 for nutrient and organoleptic evaluation.
- 4 crops were grown and shipped to JSC for organoleptic testing.
- Final ranking performed on down selected crops.

Growth Studies

Plants are grown in a controlled environment chamber at KSC, with environmental conditions set to mimic those on ISS.



Horticultural Factors

- Percent germination

Spinach had poor germination



- Speed to maturity

Chinese cabbage and Mizuna had excellent rapid growth



- Fresh Mass

Chinese cabbage had excellent yield



Spinach had poor yield

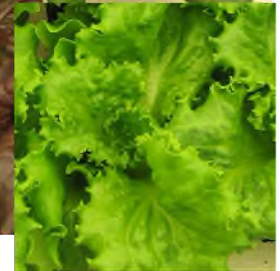


Horticultural Factors (cont.)

- Area, Height, Volume

Swiss chard,
Beet and
Mizuna had
high size

Spinach
and
lettuce
had low
size



- Plant Growth Ranking



Elemental Factors

- Dry Matter

All had similar dry matter

- Potassium

Red lettuce and Beet had excellent potassium



- Iron

Chinese cabbage had low iron excellent



Beet had high iron poor



- Magnesium

Beet had excellent magnesium



Elemental Factors

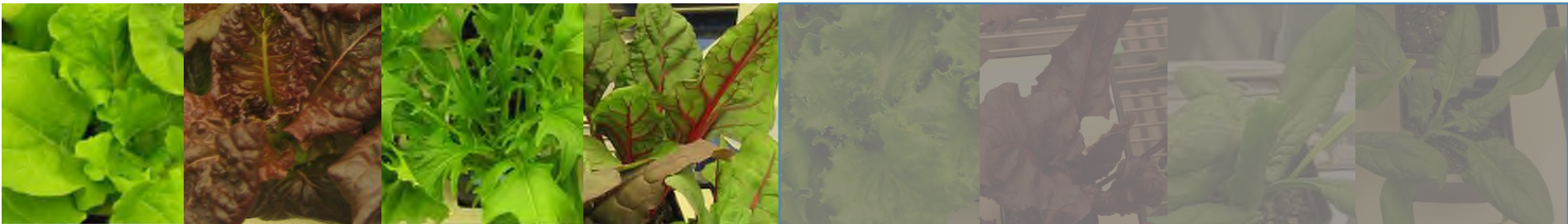
- Calcium Chinese cabbage, beet, Mizuna and Swiss chard had similar high calcium excellent



- Elemental Ranking



- Plant Growth + Elemental Combined Ranking



Nutrient Factors

- Antioxidants

Red lettuce and Swiss chard had high antioxidants
excellent



- Lutein & Zeaxanthin

Swiss chard had high Lutein and Zeaxanthin
excellent



- Vitamin K

Mizuna had high Vitamin K
excellent



- Nutrient Ranking



Organoleptic Factors

- Overall Acceptability, Flavor, & Texture

Chinese cabbage had excellent overall acceptability, flavor, and texture



- Appearance & Color

Swiss chard and Chinese Cabbage had excellent appearance and color



- Bitterness

All crops had acceptable bitterness.

- Hedonic Scale

All crops had hedonic scores > 6 for all parameters

Organoleptic Factors

- Crispness & Tenderness

Chinese cabbage was
“Just about right” for
crispness and
tenderness

excellent



- Organoleptic Ranking



- Overall Ranking



Next Steps

- Prepare top candidates for flight testing in Veggie
 - Grow top candidates in Veggie in plant pillows
 - Microbiology assessment
 - Seed sanitation
 - Red and Blue LED light testing
 - Work to manifest and fly
- Similar down selection underway with dwarf pepper and tomato varieties



Thank you!

